CAAP Quarterly Report

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Prepared for: *U.S. DOT Pipeline and Hazardous Materials Safety Administration*

Project Title: Development of New Multifunctional Composite Coatings for Preventing and Mitigating Internal Pipeline Corrosion

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For quarterly period ending: *March. 31, 2018*

Business and Activity Section

(a) Generated Commitments

No changes to the existing agreement.

Some purchase made for Q-panels over this reporting period.

(b) Status Update of Past Quarter Activities

The research activities in the 6th quarter continuing efforts by characterizing the new coatings with focus on the properties of the new coating system and particularly the features of abrasion resistance, anti-fouling and surface roughness as planned in Task 4, as summarized below.

Task 4: Characterize the new coating systems

This report mainly focus on the characterization of the new composite coating system and its hybrid systems for their mechanical, electrical and thermal properties. This document is to briefly summarize the test results and findings.

4.1 Experimental Program in the 6th Quarter

4.2.1 Experimental design

The strategy of the experimental study in this report is presented in this section. The study includes the following objectives: the performance of the composite coatings with various ratios, and the contact surface modification. The sample preparation procedures and test methods from the previous study were continually used in this study. To find out the synergistic effect of the surface morphology and incorporated hydrophobicity on the water repellency, contact angle test was performed on the coating after surface modification.

4.3 Results and Discussions

4.3.1 Characterization of the new coating

This section presents the evaluation of mechanical and electrical properties in epoxy nanocomposites from corrosion resistance, abrasion, and contact angle.

a) Corrosion barrier performance using the EIS

Results that obtained from Potentiostatic EIS test were summarized in this section. Generally, excellent corrosion barrier effect was observed. A very small variance of Zmod curves between the samples with varied mix ratios was observed in Fig. 1.

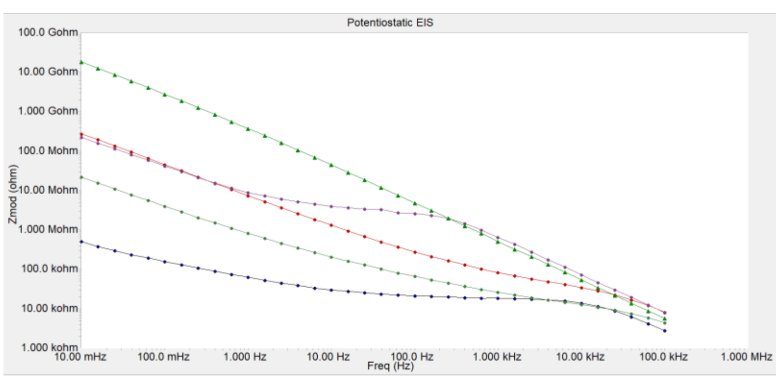

Figure 1 Impendence curve for the composites

b) Abrasion resistance

Wear index values of the new coatings were obtained from abrasion test to demonstrate the abrasion resistance. All of the new composites could have certain improvement in terms of wear index, as compared to controlling references.

c) Contact angle test

Compare with the last report, similar results of the contact angles tests were obtained. It is easy to observe that the contact angle was decreased if using hydrophilic materials.

d) Dogbone tensile test

The tensile properties of the new coatings are investigated, and the results include maximum tensile stress, strain at failure, and Young's modulus which was obtained by the dogbone tensile test (ASTM D638). The result indicates that the combination of nanoparticles could form a more robust nanoparticles network to strengthen the mechanical properties of a coating. Furthermore, the results of failure strain further confirmed that the new coating exhibits relatively higher ductile, as compared to conventional coatings.

e) Scanning Electron microscopy (SEM)

Figs 2 and 3 illustrated the fracture surfaces for specimens that fractured under tensile stress. The relatively smooth surface was observed in neat epoxy comparing with the new composites, while the higher surface roughness and more compacted cleavages were observed in the new coatings, indicating the signs of signs of higher energy absorption and better fracture resistance.

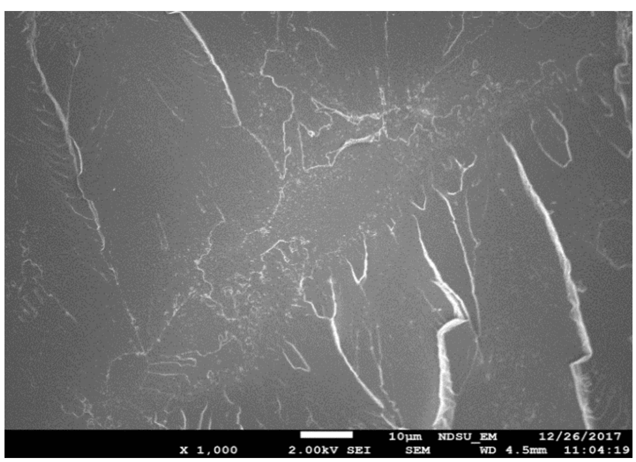

Figure 2 SEM image of fracture surface for neat epoxy

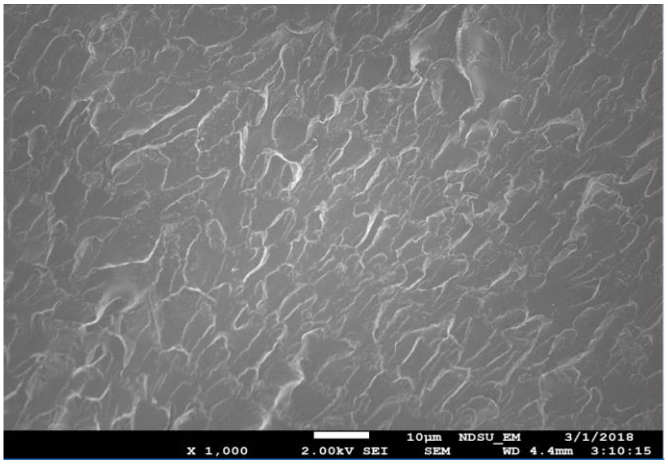

Figure 3 SEM image of fracture surface of the coating

4.4 Summary

The following findings and discussion were revealed from the results of our experimental program:

- The reinforcements of the new coating lead to a dramatical improvement in abrasion and tensile strength, as well as the corrosion resistance. Also, the fracture surface is significantly rougher for all the nanocomposites than the pure epoxy which indicating the signs of signs of higher energy absorption and better fracture resistance.

- However, it is easy to observe that the contact angle were decreased in the hybrid coating systems. Based on the results from AFM and SEM, the reduction of the hydrophobicity is caused by the extremely low roughness in the composite.

- The water repellency was significantly increased by modifying the surface texture of the nanocomposite.

4.5 Future work

The following targets, as initially planned in Task 4, will be focused on the next step based on the current experimental results as follows:

- Characterization of the new coatings using different dosage for hybrid systems.
- Characterization of the new coatings using more detailed microstructures.
- Characterization of the new coatings particularly for anti-fouling properties.